TRANSIMS TRAVELOGUE

May 1996

TRANSIMS TRAVELOGUE describes current activities within the TRANSIMS project.

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WHAT IS TRANSIMS?

The TRansportation ANalysis and SIMulation System (TRANSIMS) is one part of the multi-track Travel Model Improvement Program sponsored by the U.S. Department of Transportation, the Environmental Protection Agency, and the Department of Energy. Los Alamos National Laboratory is leading this major effort to develop new, integrated transportation and air quality forecasting procedures necessary to satisfy the Intermodal Surface Transportation Efficiency Act and the Clean Air Act and its amendments.

TRANSIMS is a set of integrated analytical and simulation models and supporting data bases. The TRANSIMS methods deal with individual behavioral units and proceed through several steps to estimate travel. TRANSIMS predicts trips for individual households, residents and vehicles rather than for zonal aggregations of households. TRANSIMS also predicts the movement of individual freight loads. A regional microsimulation executes the generated trips on the transportation network, modeling the individual vehicle interactions and predicting the transportation system performance. Motor vehicle emissions are estimated using traffic information produced by TRANSIMS. TRANSIMS major advantage for air quality analysis is the detail it provides regarding motor vehicle operation.

PROJECT APPROACH

We are developing an interim operational capability (IOC) for each major TRANSIMS component: Household and Commercial Activity Disaggregation, Intermodal Route Planner, Transportation Microsimulation, and Environment (primarily air quality). As each IOC is ready and with the collaboration of a selected MPO, we will complete a specific case study to confirm the IOC features, applicability, and readiness. This approach should provide timely interaction and feedback from the TRANSIMS user community and interim products, capabilities, and applications.

The Traffic Microsimulation is emphasized in the first IOC, with the goal of having it ready for testing in mid-1996. We are working with the selected MPO, North Central Texas Council of Governments (NCTCOG) (Dallas-Fort Worth), on the case study that the IOC should support.

REVISED CASE STUDY

In the November 1995 TRANSIMS Travelogue, we described a proposed case study that emphasized examination of several freeway alternatives for reducing traffic congestion. Since that time we have revised the case study to highlight unique TRANSIMS features and to maintain the focus on the traffic microsimulation—the emphasis of the first IOC.

The revised case study will continue to examine the transportation system performance within a 16-square-mile region of interest (ROI) along the Lyndon B. Johnson Freeway (I-635). NCTCOG is updating the case study network to include local streets for a 25-square-mile ROI so that we can study both the boundary effects on the ROI and the necessity for modeling local streets. As before, but with a slightly different view, we will examine infrastructure alternatives to traffic congestion reduction.

The new case study will illustrate TRANSIMS's ability to partition the benefits and costs of a transportation infrastructure change among subpopulations of travelers. For demonstration purposes we have chosen to focus the study on a major shopping/business center, the Galleria area, and the travelers to or from that area. A local system alternative will involve a non-freeway system change which we would expect to benefit the Galleria travelers, and possibly other travelers to some extent. A global (non-local) alternative, for example, an additional freeway lane in both directions through the ROI, also is intended to benefit the Galleria travelers, but would be expected to benefit all travelers to the same or comparable extent.

The proposed study matrix is shown in the following figure. Case 1 represents a microsimulation of the existing transportation system. Although it was not in our initial plans, we now believe that we will be able to feed the micro-simulation results, such as travel times, into the route planner and derive new traveler routes that account for the observed micro-simulation dynamics. The question mark indicates some uncertainty in our ability to do this iteration at this point in the project. Currently we intend a single iteration (planner-> microsimulation->planner->microsimulation) and to use the second microsimulation results in the comparisons between cases.

	With Galleria Trips	Without Galleria Trips
Base Infrastructure	Case 1 Replan?	Case 4
Local Alternative	Case 2 Replan?	Case 5
Global Alternative	Case 3 Replan?	Case 6

Case 2 represents the local alternative. For this case the planner-microsimulation iteration will account for the system change, and the microsimulation will use those revised trip plans. Similarly, Case 3 represents the global alternative.

We currently are defining relevant measures of effectiveness for the comparisons between cases, but, in addition to the traditional measures such as VMT, VHT, etc., we will include variances in these quantities. These MOEs will quantify the benefits obtained from the alternatives.

In doing such comparisons we should choose the MOEs carefully. We must distinguish between the benefits to the total subpopulation and the benefits normalized on a per person basis or per vehicle basis. Thus, we can compare the subpopulation total improvement in travel time or the average improvement in travel time. We also must distinguish between local and global MOEs. A person may benefit locally from an improvement, but it may be only a small portion of his overall trip. Similarly, the MOEs are time sensitive. Recognizing these caveats, we will carefully choose the MOEs before analyzing and comparing the subpopulation benefits as discussed in the following paragraphs.

For the cases represented by the right boxes, we will remove, from the trip plan set of the respective left box, those travelers' trip plans that originate or terminate in the Galleria area. We will <u>not</u> replan the trips for the non-Galleria travelers when excluding the Galleria travelers. Replanning would introduce additional travelers' trips into the ROI and the system we are studying, disrupting the partitioning we seek. TRANSIMS's beauty is that it permits such mathematical manipulations and abstractions to partition and understand both the demand and the supply sides of the transportation system.

Thus, though the non-Galleria travelers' trip plans will account for the Galleria travelers, in the traffic microsimulation execution the non-Galleria vehicles will not interact with the Galleria vehicles (because they won't be on the network). Comparing the results of the right cases with the left cases using measures, such as time of travel, travel time variability, and trip plan satisfaction, should yield the impact of the Galleria travelers on the other travelers.

However, such direct comparisons are not useful in themselves because the non-Galleria travelers impact the Galleria travelers in a comparable way, probably even worse as there are many more non-Galleria travelers. The interesting results occur when comparing the subpopulation benefits resulting from the transportation system alternatives. Because TRANSIMS tracks individual travelers through-out the simulation (planner and micro-simulation), we can measure how each alternative benefits subpopulations. For example, from Case 1 to Case 2 we can measure how the local alternative benefits each subpopulation: Galleria and non-Galleria travelers. In addition, from Case 4 to Case 5 we can determine whether the non-Galleria subpopulation benefits even if the Galleria subpopulation is not present when the non-Galleria travelers execute their travel plans.

To illustrate the possible outcomes of the case study, suppose the benefits for the non-Galleria and Galleria subpopulations from Case 1 to Case 2 are denoted by N_2 and G_2 respectively, and for the non-Galleria subpopulation from Case 4 to Case 5, by N_5. If all three benefits are significant and comparable, then the local alternative affects the subpopulations equally and each should expect responsibility for an equal partition of the alternative's cost.

If N_5 is significant, but N_2 is not, then the benefit to the non-Galleria travelers arises just by reducing the demand, which could be a reduction by any subpopulation. If G_2 is significant and N_2 and N_5 are not, then the Galleria subpopulation benefits whereas the non-Galleria subpopulation doesn't regardless of the Galleria subpopulation presence. In this instance, the Galleria subpopulation should expect to finance the alternative's costs. If N_2 and N_5 are significant, but G_2 is not, then the benefits are incurred primarily by the non-Galleria subpopulation, and the Galleria subpopulation should not expect to contribute to the alternative's cost.

We can examine other possible combinations and infer benefits and financing equity to the subpopulations. The point is that the TRANSIMS approach of following travelers throughout the microsimulation allows partitioning of benefits and liabilities among subpopulations. Furthermore, TRANSIMS permits additional MOEs, e.g., variance in time of travel and trip plan satisfaction by subpopulation, not present in current planning models.

A PRACTITIONER'S PERSPECTIVE

Most of the work to date in the TRANSIMS Initiative has focused upon the development of new capabilities, and has of necessity concentrated on software design and development. While interesting in academic terms, practitioners have had a difficult time assessing the applicability of these developments to their practice. The case study offers transportation planners and engineers the opportunity to examine the potential of large scale transportation systems simulation within the context of a real-world transportation planning problem. By focusing on the microsimulation—the most computationally demanding element of TRANSIMS—the case study will give potential users a frame of reference with which to gauge the capabilities and scalability of the system.

One very noteworthy capability unveiled during the case study will be the simultaneous collection of statistics for both links and the travelers traversing them. While currently available traffic simulation and travel forecasting models collect some of these data, none can handle both (or the interactions between them) in a unified manner. Moreover, data on the variability of various measures of effectiveness will be collected as well. Information on variability is often as influential as absolute measures in travel decision-making, especially in goods movement and public transport planning.

The case study has been deliberately designed to illustrate the ability to conduct equity analyses—the so-called "winners and losers" identification. By removing certain classes of travelers (those destined to and from the Galleria in our case study) from the simulation without removing the perception of the their effect on the network by the remaining users, we can finally examine both efficiency and equity issues that are foremost in the minds of public policy makers. While we will focus on a single user class, it will be possible to subdivide the simulation elements (both networks and users) into multiple groups, allowing the visualization and analysis of joint distributions which cannot be analyzed using current tools, or even observed in the real world. The ability to assess whether targeted user groups are affected in the intended way will be an important analytical contribution. By combining measures of network response and changes in user behavior, we will be able to conduct truly holistic analyses of complex transport problems and issues.

— Rick Donnelly, Transportation Planning and Engineering consultant, Parsons, Brinckerhoff, Quade & Douglas, Inc.

INTERIM ROUTE PLANNER

We achieved our goals to provide an interim route planner capability that supports the microsimulation IOC. Those goals are:

1) Provide a representative set of NCTCOG trip plans so the microsimulation IOC can be demonstrated.

2) Establish data structures between the HCAD and Planner, and between the Planner and Microsimulation, consistent with our long-term design.

3) Implement basic versions of the Trip Plan Generation and Goal Measurement phases.

For the first goal, we generated 10.3 million trip plans for individual travelers across the entire NCTCOG region. Primary inputs included the Dallas-Fort Worth network augmented with mid-link addresses (labeled "parking accessories," which represent the travelers' origins and destinations), individual traveler demographics, and individual traveler activities (type, location, and start, end, and duration time intervals). We identified one half million trip plans as passing through the 25-square-mile region for the traffic microsimulation (vicinity of the LBJ Freeway and Dallas North Tollway). We stored these plans in the TRANSIMS Oracle database for subsequent use by the microsimulation.

We discussed the "quality" of these plans with NCTCOG. Although we cannot perform a thorough calibration and validation process at this early point in the Planner's development, we believe it is useful to compare these trip plans with known data and NCTCOG experience. This information is needed for the upcoming Case Study. Future planner calibration and validation will occur after we have implemented the preference adjustment and superposition phases, and established the planner-microsimulation feedback loops.

We compared several actual link traffic counts and Planner link volumes over a 24-hour period. [Note: It is more appropriate to compare <u>microsimulation</u>

link volumes with actual counts. Trip plans represent travelers' intentions—microsimulation output represents "actual" execution of trip plans. We expect, though, that trip plan link volumes will have magnitudes and link type distributions similar to actual counts.]

In general, these trip plans capture the 24-hour volume trends (e.g., AM, PM, and noon peak hours). However, the total link volume may be too high, and volume by roadway classification (freeway, arterial, collector, etc.) may not be distributed correctly. We believe an interim superposition algorithm is necessary before we can draw any substantive conclusions. In the meantime, these plans will allow us to demonstrate the microsimulation capabilities and to perform the upcoming Case Study.

Second, the Planner's basic data structures are in place. We are transferring traveler and activity data from the Household and Commercial Activity Disaggregation to the Planner and are placing trip plans into the trip plan database.

Third, we implemented both the basic trip plan generation and goal measurement phases. The generation phase uses stochastic and optimal routing algorithms. Consistent with our underlying premise that many travelers do not use optimal routes, we rely primarily on the sto-chastic router. Individual traveler link preferences, or biases are imbedded within this router. These include a bias to head toward the destination, avoid turning, and select and remain on a freeway when far from the destination.

The goal measurement phase determines the adequacy of each candidate plan (i.e., the overall "goodness" of the specific set of sequential links in the plan) according to three travel goal thresholds: time, distance, and cost. We use a default process to select a good plan. Each traveler has his/her own set of goal thresholds, and these are generated using personal demographic attributes and expected travel times and distances between the origin and destination. For those travelers who cannot "find" a goal satisfying route/trip plan, we select the plan (among the set of candidate plans) that minimizes deviations from the traveler's goals.

FURTHER INFORMATION

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